

External actors, high value resources and
threatened species: Shark fin commodity chains of
Northern Madagascar, interception for
conservation.

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Table of Contents

List of Acronyms and Abbreviations	4
Abstract.....	5
Acknowledgements	6
1. Introduction.....	7
1.1. Wildlife trade: a billion dollar industry of unsustainability?	7
1.2 The trade in shark fins	8
1.3 Data paucity in artisanal shark fisheries.....	9
1.4 Study Focus: Northern Madagascar	10
1.5 Aims and Objectives	11
2. Background.....	13
2.1 Current policy and conservation initiatives.....	13
2.2 Modelling the market: Previous studies of the shark fin trade	14
2.3 Commodity Chain Analysis	15
2.4 Shark exploitation and trade from traditional and artisanal fisheries	17
2.5 Madagascar: Shark fisheries and the shark fin trade	17
2.6 Study Area: Northern Madagascar	19
3. Methods	21
3.1 Site Selection	21
3.2 Analytical Framework.....	22
3.3 Semi Structured Interviews	22
3.4 Landing Site Data	24
3.5 Species Identification and Use of Local Names.....	24
4. Results	25
4.1 Description of the Fishery	25
4.1.1 <i>Catch composition</i>	25
4.1.2 <i>Utilization and Processing</i>	27
4.2 Structure of the Commodity Chain	29
4.2.1 <i>Nationality</i>	31
4.2.2 <i>Trade routes and Transport</i>	31
4.3 Patterns of Pricing and Income	33
4.3.1 <i>Pricing</i>	33
4.3.2 <i>Interlinked commodity chains</i>	36
4.4 Means of Access and Control	36
4.4.1 <i>Access to fishing and perceptions of the fishery</i>	36
4.4.2 <i>Access into the trade</i>	37
4.4.3 <i>Monitoring and Regulations</i>	37
5. Discussion	40
5.1 Problems with identification and quantification.....	40
5.2 Structure of the Commodity Chain	41
5.2.1 <i>Actors in the chain</i>	41
5.2.2 <i>Income and Pricing</i>	42
5.3 Interlinked Commodity Chains	43
5.4 Points of entry for Conservation action?	44
5.4.1 <i>Fishermen: the migration issue</i>	44
5.4.2 <i>Middlemen: the weakest link?</i>	45

5.4.3 An international focus for conservation action.....	46
5.5 Remaining Issues for Future Research	46
5.5.1 Monitoring shark populations.....	46
5.5.2 Characterisation of the shark fishery.....	47
5.5.3 Quantification of the trade in shark fins.....	47
5.5.4 Recommendations for improvements.....	48
5.6 Concluding Remarks	48
6. References	50
Appendix I.	
Appendix II.	
Appendix III.	

List of Acronyms and Abbreviations

C-3	Community Centred Conservation
CCA	Commodity Chain Analysis
CITES	Convention of International Trade in Endangered Species of Wild Fauna and Flora
CI	Conservation International
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CoP14	Conference of the Parties 14
CPUE	Catch Per Unit Effort
EEZ	Exclusive Economic Zone
FAO	Food and Agricultural Organisation
ICCAT	International Commission for Conservation of Atlantic Tunas
IPOA	International Plan of Action for the Conservation and Management of Sharks
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unregulated and Unreported Fishing
MNP	Madagascar National Parks
NGO	Non-Governmental Organisation
RFMO	Regional Fisheries Management Organisations
SSG	Shark Specialist Group

Abstract

Wildlife trade threatens many exploited populations with unsustainable levels of extraction. The shark fin trade is perceived as a primary driver in the decline of many shark populations. The targeting of sharks by local fisheries to feed the demand for shark fins is contributing significantly to this decline. Yet despite this, the structure of the commodity chain from artisanal and traditional fisheries remains ambiguous. This study investigates the structure and operation of the shark fin trade in northern Madagascar in an attempt to generate locally relevant socio-economic information and meliorate national conservation management.

A combination of direct observation and semi-structured interviews was used to identify: the different types of actors along the commodity chain; trade routes; means of access and control; and patterns of price and income. Attempts were made to identify those species most heavily exploited by the trade.

A baseline commodity chain analysis reveals that domestic prices for shark fins have increased dramatically over the past 15 years. Anecdotal reports of declines in shark populations are worrying, as are reports of heavy species-specific exploitation. The shark fin commodity chain is interlinked with another high value resource chain for the trade in sea cucumbers. This study highlights the pressing need for further research to determine the socio-economic importance of these resources to local communities. Furthermore, there is some evidence to suggest that the best entry point along the shark fin commodity chain for conservation intervention would be the targeting of “middlemen” and commercial traders. However, decisive action at a national, regional and international scale is needed to ensure the future sustainability of shark fisheries in Madagascar.

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1. Introduction

1.1. Wildlife trade: a billion dollar industry of unsustainability?

The complex issue of wildlife trade is linked to some of the most important underlying causes of biodiversity loss. Estimated to be worth billions of dollars every year, tackling the problems of wildlife trade poses a major challenge to the conservation of exploited species (Oldfield, 2003; Roe, 2008). Creation of common markets, technological advances and the increasing globalisation of commerce make maintaining wildlife trade sustainable, reducing negative indirect impacts on biodiversity and ensuring trade is legal, infinitely more difficult (Oldfield, 2003). Compounding the issue further is the constantly evolving nature of the trade, both legal and illegal; from the targeting of new species as preference species become depleted, to new methods for avoiding controls and regulations (Oldfield, 2003).

Regulations surrounding wildlife trade are complicated, agreements governing access to resources and markets are often long standing domestic requirements others are externally motivated, and the associated enforcement effort and effectiveness adds another dimension. Examining the impacts of wildlife controls is therefore not straightforward (Roe *et al.* 2002). Some of the poorest countries, often those with the richest biodiversity have the most commercially significant wildlife trade with trade flow predominantly exported to developed countries (Roe *et al.* 2002). These countries also frequently suffer the effects of poor governance and the influence of corruption. In low-income countries, the definition between wildlife trade for subsistence and trade for additional income is indistinct, and where trade is not merely for subsistence, large declines in target populations can be weathered before the trade becomes unviable (Oldfield, 2003).

The international trade in wildlife is very poorly documented; species and products involved, trade volumes and trade values are all elements largely data deficient (Roe *et al.* 2002). The annual reporting requirements of the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) recognise the importance of monitoring and regulating trade, and of providing information on the legal trade in species listed by the Convention (Roe *et al.* 2002; Clarke, 2003; CITES, 2011). However, the trade in CITES-listed species reflects only a very small part of a much larger trade in wildlife resources (CITES,

2011).

Quantifying global wildlife trade is problematic for a variety of reasons. Within structured aspects of trade, domestic or international, commodity chains are rarely monitored, and those statistics that do exist are dispersed and difficult to compile; there is even less data available for the large amount of informal trade networks (Roe *et al.* 2002).

1.2 The trade in shark fins

The international trade in shark products, coupled with the increasing demand for shark fins, has been recognised as a major driver in the exploitation of worldwide shark populations (FAO, 2009; Clarke, 2003). The well documented decline in shark populations (Baum *et al.* 2003; Myers and Worm, 2003; Baum and Myers 2004), the vulnerability of sharks to exploitation (Abercrombie *et al.* 2005; Stevens *et al.* 2000) and their importance to the functioning of marine ecosystems (Myers and Worm, 2003), make the analysis of shark fisheries and trade of critical importance.

Trade in shark fins has (recently) expanded on a global scale, with trade through Hong Kong growing at an annual rate of six per cent (Clarke, 2004). This has been linked to increases in disposable income in Mainland China (Clarke, 2003). The increasing demand for shark fins has been accompanied by a significant increase in global prices, resulting in shark fins being one of the most highly valued sea food commodities (Abercrombie *et al.* 2005). Both industrial and subsistence fisheries have increased shark landings as an opportunity for greater cash income (Rose, 1996). In some cases, the Food and Agricultural Organisation (FAO) and Non-Governmental Organisations (NGOs) have assisted in the development of targeted shark fisheries as a human development tool (Rose, 1996). Characterising the trade in shark fins at this local level is critically important. Domestic commodity chains need to be understood in terms of structure and incentives along the chain if effective policy is to be implemented.

Accurate information on the volume of trade in shark products, and examining the role of trade regulation for conservation and sustainable use, is critical considering the importance of international trade in driving the global exploitation of shark populations (FAO, 2009).

Monitoring of shark fisheries and trade needs to be improved if conservation action is going to be implemented successfully; yet few shark fishing states are committed to collecting the data necessary to inform and implement management measures (FAO, 2009; Fowler and Séret, 2010).

The absence of robust statistics for the volume and trend of international trade in shark species is a major hindrance when formulating management plans aimed at limiting overexploitation. Alternative methods for estimating harvest levels have been developed for species mainly taken for international trade (e.g. Clarke *et al.* 2006); monitoring trade volumes can act as a proxy for the scale of shark catches. A number of complications in estimating volumes and trends of international trade include: discrepancies between source data (i.e import and export records) and the lack of taxonomic resolution across the market chain allowing the verification of trade and catch information (FAO, 2009).

The analysis of trade structure is important in circumstances where compliance is limited because it can highlight gaps where management intervention could be most effective. The difficulties surrounding shark management illustrate the importance of using various complimentary techniques including trade-based studies to assess exploitation rates and population status (Stevens *et al.* 2000).

1.3 Data paucity in artisanal shark fisheries

Industrial fishing targeting shark species has gained much notoriety in recent years. However, smaller scale artisanal fisheries contribute considerably to global elasmobranch landings (Bonfil, 1997; Vannuccini, 1999; Bizzarro *et al.* 2009); likely contributing to the declines in abundance for shark populations in inshore and coastal waters (Walker, 1998). Artisanal fisheries are generally data poor, with limited knowledge on volumes and composition of direct catch, often owing to the logistical difficulties in surveying such fisheries in remote and developing areas (Humber *et al.* 2011).

Gathering species-specific information in developing countries can be time consuming and expensive (Humber *et al.* 2011), and such baseline information is greatly lacking in artisanal shark fisheries (Bizzarro *et al.* 2009). Data deficiency surrounding life histories of target

species, combined with a large uncertainty regarding the scale and dynamics of such fisheries, highlight an urgent need for a robust framework integrating biological and socioeconomic assessment (Curtis and Vincent, 2008; Dulvy *et al.* 2008). As without an understanding of these characteristics, development and implementation of any management plans will be ineffective by not reflecting the importance of shark catch to local livelihoods (Bizzarro *et al.* 2009).

Due to data paucity, high complexity, and the difficulties in assessment and monitoring, management of artisanal fisheries is often inadequate or absent (Martin-Smith *et al.* 2004; Curtis and Vincent, 2008). Regulations can be equally challenging to enforce (Curtis and Vincent, 2008), and the documented declines in shark numbers in regions where some management exists (e.g. North Atlantic stocks) have raised concerns for those areas whose management is poorly enforced or non-existent, where declines may be even greater and largely unreported (Abercrombie *et al.* 2005). In order to ensure the sustainability of artisanal fisheries, filling these data gaps to form strong scientific foundations for management is a priority.

1.4 Study Focus: Northern Madagascar

Recent production figures acknowledge that shark fisheries in Madagascar are now over-exploited with overall shark production falling from 50 tonnes in 1997 to 15 tonnes in 2002 (Soumy, 2004). Additionally shark stocks have not been the subject of specific management measures to reduce or counteract this exploitation, only general fishing regulations, for example, the banning of destructive practices (i.e. beach seining) are in place (Soumy, 2004).

Traditional fisheries are responsible for the most important volume of overall catch, with 53% of the total marine fish catch in 2002 (Soumy, 2004). It is therefore imperative to understand how these fisheries utilise sharks. Shark landing data is frequently absent, particularly at species level, therefore monitoring the trade in shark products is a way to assess the importance of shark exploitation to local fishermen. Such rich marine biodiversity, providing a crucial source of protein and income for coastal communities, yet with few resources available for management to ensure sustainability is a cause of grave international concern (Ban *et al.* 2009).

Lack of current data on the trade in shark products is a barrier to the creation of viable management plans, and understanding the structure of the commodity chain is a vital part of identifying the most appropriate conservation action, by highlighting actors in the chain where management would be most effective. Using a commodity chain analysis framework, I attempt to assess the structure and operation of the trade from traditional and artisanal fisheries, identify and prioritise points in chain for management and identify those areas with a need for further research.

1.5 Aims and Objectives

Aim:

The trade in shark fins from artisanal fisheries is poorly understood. Elucidating the structure of trade from traditional and artisanal fishing communities in Northern Madagascar is necessary to inform resource management decisions and facilitate monitoring of the trade. This study aims to employ key informant interview techniques to fulfil the below objectives:

Objectives:

- Explore the trade in shark fins from traditional and artisanal fisheries in Northern Madagascar highlighting key routes of transport and locations of importance for commerce.
- Analyse the structure of trade from northern Madagascar in terms of a commodity chain; a new approach to studying the shark fin trade.
- Report on the structure of the trade in comparison with other high value marine resource commodities, such as sea cucumbers.
- Investigate the species-specific implications of the trade in shark fins; which species are the most heavily exploited, why these species are targeted and the implications this has for populations.

- Assess the suitability of management and conservation interventions with respect to various actors along the commodity chain.

2. Background

As a historically undervalued fishery, ignored by managers and conservationists alike, the rapidly increasing commercial value of shark fisheries, predominantly driven by the shark fin trade has seen a greater recognition and paramount increase in concern for the status of shark populations. In the following section, I have undertaken a review of the approaches used to understand the operation of the fin trade and the current knowledge of the trade from small-scale fisheries. I begin with a summary of the major international initiatives and policies that currently promote the conservation of elasmobranchs and how this pertains to management in small-scale fisheries.

2.1 Current policy and conservation initiatives

By 2001, National and Regional Shark Plans were to be prepared in line with population assessments by all fishing nations and Regional Fisheries Management Organisations (RFMOs), following the 1999 FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) (FAO, 2000). Progress has been slow, lack of political will is a major impediment to improving the status of sharks and those RFMOs considering their remit for shark management have called for increased data (e.g. ICCAT (International Commission for Conservation of Atlantic Tunas), 2007) (Fowler and Cavanagh, 2005) and to date, no RFMOs managing sharks have adopted catch limits (Camhi *et al.* 2009).

Alternatives to RFMOs for enforcing conservation measures are the international and regional treaties seeking to promote sustainable management of listed species. Regional treaties, for example, the Barcelona and Bern conventions, and international wildlife conservation agreements, CITES and CMS (Convention on the Conservation of Migratory Species of Wild Animals), applied in conjunction with effective fisheries management may be the best mechanisms for regulation of shark exploitation (Fowler and Cavanagh, 2005).

The permit system regulated by CITES, intended to limit international trade to sustainable levels currently has three pelagic shark species listed on Appendix II: the whale, basking (both listed in 2002) and white shark (listed 2004) (Fowler and Cavanagh, 2005). The same three species are listed on the CMS appendices (Dulvy *et al.* 2008). In addition, all species of

sawfishes (family Pristidae) were listed in CITES Appendix I (except *Pristis microdon*, listed in Appendix II), following decisions resulting from CoP14 (IUCN SSG, 2011). Developing countries, including Madagascar, as signatories to CITES, are provided with a robust framework against which to design tailored management plans to tackle the threats to shark populations.

2.2 Modelling the market: Previous studies of the shark fin trade

The analysis of catch data is always preferred over analysis of trade data for establishing the status and sustainability of fisheries populations (Clarke, 2003). However, in the absence of catch data, monitoring the trade in wildlife is a useful tool for tracking potential unsustainable exploitation rates. The most detailed studies of the trade in shark fins, by far, have been those by Clarke *et al.* (2005; 2007; 2008 etc.). They have provided us with a global estimate of shark catch (see Clarke *et al.* 2006), an analysis of social, economic, and regulatory drivers of the fin trade (see Clarke and Milner Gulland, 2007) and developed new methods for monitoring shark populations through trade data (see Clarke *et al.* 2005).

Utilisation and analysis of market, trade and consumption information in an attempt to estimate global shark catch has highlighted the gross inaccuracies that are probably present in FAO shark production data (Ng, 2009). Clarke *et al.*'s (2006) fishery-independent estimates place the quantities of actual shark biomass caught at three to four times higher than the 754 000 tons reported to the FAO in 2006 (Ng, 2009). Combined with a woefully inadequate grasp of species-specific data, little reliable and accurate data on shark numbers is available for the basis of truly science-based policies.

Genetic methodologies developed in other fields have thus far helped identify priority species in the shark fin trade for specific conservation action. Genetic studies are currently helping to identify those species targeted for the fin trade (e.g. Shivji *et al.* 2002) and identify the volumes of trade in exploited species (e.g. Hoelzel, 2001). These approaches to monitoring trade have direct relevance to conservation as the trade in shark fins is currently poorly documented at species level (Vannuccini, 1999). Where genetic methods cannot be employed due to a lack of resources, other identification methods have been used with limited success (see Cartamil, 2011); the use of field identification guides with community

members and local names is considered particularly unreliable.

A study of the shark fin trade provides essential information for shark management and conservation, and also builds upon, and assists in advancing trade analysis methods for other products derived from various other wildlife species. Socio-economic factors are important considerations, yet have been neglected in studies on the shark-fin trade which have primarily focused on the quantification of trade volumes and species identification. However, it is critical that we assess the inevitable trade-offs arising from managing exploited species of high conservation concern in the face of local communities dependent on the resource (Curtis and Vincent, 2008). Qualitative methods to characterise the structure of the trade can be particularly valuable when harvest data are lacking, or there is no institutional framework in place by which fisheries are managed (as is the case for most artisanal/traditional shark fisheries). Progressing research on the shark fin trade in terms of social and economic drivers at a local level is an urgent priority.

2.3 Commodity Chain Analysis

A commodity chain is a series of interlinked exchanges connecting extraction or harvesting, production and distribution resulting in a commodity that can then be exchanged on the world market (Ribot, 1998). Analysis of the commodity chain can reveal who benefits from natural resources, how they benefit and the patterns of benefit distribution (Ribot, 1998). Commodity chain analysis (CCA) is a valuable technique in analysing marketing chains from production through to outputs, assessing how policy, access and institutions affect local production systems (Tallec and Bockel, 2005). A quantitative analysis of outputs, prices and value along the commodity chain, and an investigation into the means of access and regulation of the chain can inform management (Ribot, 1998), and enables portrayal of the linkages and distribution that give value to natural resources (Tallec and Bockel, 2005).

The first stage in CCA is chain mapping; an overview of the chain, product flows, the actors involved and the interactions between them (Tallec and Bockel, 2005). A more detailed look at how actors enter and exit the trade, and the means used to control this access is then established (Ribot, 1998). Commodity chain analysis has been widely used to assess agro-food systems (e.g. Islam, 2008; Bitzer *et al.* 2008) from an international perspective,

exploring the links between production and globalised markets and to assess the economic pressures and international political influence on the trade in forestry products (e.g. Putzel, 2009). This approach is also beginning to be utilised to analyse fisheries commodities (see Hempel, 2010).

On a more regional scale, the trade in natural resources from developing countries has often been studied using this approach, (e.g. cardamon in Vietnam; Tugault-Lafleur and Turner, 2009). Rapidly expanding global markets and consequently rapidly developing commodity markets for a range of natural resource products can quickly lead to unsustainability. It is therefore imperative that an understanding of how the commodity chain operates, in order to identify suitable monitoring points to keep track of the fluctuating supply and demand, is established. Bushmeat studies have employed commodity chain analysis to map points of entry into the trade where conservation intervention would be most effective. These studies have advanced our knowledge of consumption patterns, consumer preferences and the interplay between supply and demand of exploited resources (e.g. Fa *et al.* 2002; Rowcliffe *et al.* 2005).

Cowlshaw *et al.* (2005) used a commodity chain approach to investigate the structure and operation of a bushmeat commodity chain in Ghana. Following the flow of bushmeat from extraction to consumption, they determined the number and nature of actor groups involved, connections to one another and the income of actor groups along the chain. By examining the trade in this way, a greater understanding of how the bushmeat chain operates and therefore how best to manage it for conservation purposes was gained. However, these studies have been limited elsewhere and for other types of wildlife (Brooks *et al.* 2010).

The CCA approach holds potential for exploring the structure of the trade in shark fins at a local scale. This approach can reveal breaches in fishing regulations or illegal practices that cannot be shown by landing site surveys or compliance reports (Kinch *et al.* 2008). Regular monitoring of prices over time across different actors in the commodity chain can provide an understanding of social aspects in fishing communities to inform management action (Kinch *et al.* 2008).

2.4 Shark exploitation and trade from traditional and artisanal fisheries

The international trade in wildlife poses a large threat to biodiversity, and consequently has received much attention. However, a large proportion of commerce from natural resources is domestic and unregulated (Barker and Schluessel, 2008). Whilst the trade in shark fins has been explored on an international scale, with particular focus on estimating the trade volumes passing through large commercial markets (e.g. Hong Kong, see Clarke *et al.* 2005), little has been done to understand the structure of the commodity chain from local or artisanal fisheries.

World shark catches and fin production are compromised substantially from industrial fisheries, however, there is increasing evidence that artisanal fishermen are now capitalising on the lucrative fin trade and producing greater quantities of shark fins (Clarke, 2003). These relatively small fishing operations have the ability to cause rapid depletion of sharks and greater effort in monitoring artisanal shark landings to obtain fishery and biological information to manage the fishery and conserve stocks is required (Castilo-Géniz *et al.* 1998). Combining monitoring of the fishery with an understanding and monitoring of the trade in shark fins is a much-needed approach.

The FAO (2008) workshop, identified that the lack of compatibility of taxonomic resolution across the market chain is a limiting factor in allowing comparable species identification from catch to trade. Resolving the identification problems has been attempted by Cartamil *et al.* (2011) through the use of a novel survey method involving the identification of discarded carcasses. Community monitoring for identification of catch in other small-scale fisheries has been approached (e.g. sea cucumbers; McVean *et al.* 2005), but has yet to be successfully employed in the identification of elasmobranchs. Even less has been done to establish the species present in trade from these fisheries, however, genetic methods used at a higher levels of the commodity chain could be employed in these instances.

2.5 Madagascar: Shark fisheries and the shark fin trade

Madagascar is the world's fourth largest island known for its high biological diversity and endemism. Whilst identified as a top conservation priority (Myers *et al.* 2000), little is known about its marine habitats (Cooke, 2002), and consequently policy is focused upon the

better known terrestrial environment (Cinner, 2009; Harris, 2007). Madagascar's Exclusive Economic Zone (EEZ) covers an area of 1 140 000km² making the enforcement of fishery legislation, in the face of limited resources, extremely difficult. Yet with fishing communities heavily dependent on marine resources for income and subsistence (Epps and Benbow, 2007), the management of fisheries is critical.

Fishing in Madagascar can be categorised into three major sectors; traditional, artisanal and industrial:

- Traditional fisheries: on foot/dug out canoe (pirogue);
- Artisanal: motorised boats using engines <50hp;
- Industrial: boats with engines >50hp.

The traditional fishery is responsible for the most important volume of overall catch, with 53% of the total marine fish catch in 2002 (Soumy, 2004). It is therefore imperative to understand how these fisheries utilise sharks. Exploitation of sharks in Madagascar has been evaluated as over-exploited and the overall production has fallen from 50 tonnes (1997) to 15 tonnes (2002) (Soumy, 2004). However, shark stocks have not been the subject of specific management measures to reduce or counteract this exploitation; only general fishing regulations are in place (Soumy, 2004).

Illegal foreign vessels also target populations of sharks around Madagascar's coastline (Le Manach, *in press*), the persistence of Illegal, Unregulated and Unreported (IUU) fishing is a known and widely publicised problem in Madagascan waters. Industrial fishing fleets, such as the European tuna fishing fleet, are subject to heavy bycatch (Kroese and Sauer, 1998), and no assessment of shark-bycatch rates from these fisheries has yet been published. The reconstruction of time-series data of shark catches by Le Manach (*in press*) presents a different picture to the officially reported data for shark landings, where import and export data is lacking or incomplete. The reported decline in Madagascar's shark fishery is worrying; occupational shift for fishermen is possible if these resources become depleted having large socio-economic consequences (Le Manach, *in press*).

Cooke (1997) has provided the most detailed account of the artisanal shark fisheries for the whole of Madagascar, supplying regional summaries on catch composition and characterisation of regional fisheries. Shark catch in artisanal fisheries has generally been viewed as a valuable addition to normal landings (Kroese and Sauer, 1998), targeted only when necessary and often only when expensive gear is available. However, even in the poorest countries, Madagascar being an example, fishermen are investing in outboard engines, larger vessels and gear that is known to catch shark (Kroese and Sauer, 1998) hoping to capitalise on the high economic returns from the shark fin trade. The paucity of current data on the trade in shark products is therefore a barrier to the creation of viable management plans.

With shark populations now in serious decline, the lack of enforcement and management resources, and the high socio-economic importance of shark fisheries to local communities, studies of these fisheries in Madagascar are timely. Shark landing data is frequently absent, particularly at species level, therefore monitoring the trade in shark products is a way to assess the importance of shark exploitation to shark populations. Understanding the structure of the commodity chain is a vital part of identifying the most appropriate conservation action.

2.6 Study Area: Northern Madagascar

In Madagascar, fishing pressure is concentrated along the west coast (Le Manach, *in press*) and the northwest has been identified as the area of greatest production for shark with the highest frequency of trade in shark products, especially via Mahajanga (Cooke, 1997). The warm weather and favourable winds allow fishermen to fish year round by undergoing frequent migrations along the coast, and from the east to west of the island. The exploitation of marine resources is likely to be influenced by these migratory fishermen (Cripps, 2009), which could have a bearing on management effectiveness.

In the early 1990s the development NGO GTZ (now GIZ), attempted to ensure the continued livelihoods of coastal communities, particularly in the Antsiranana region, by developing “undeveloped” fisheries. GTZ provided nets, allowing the targeting of sharks and training in the methods used to exploit them. Since these initiatives there have been reported declines

in shark catches, suggesting shark populations in the region are overexploited. Updates for information regarding the effect of consistent shark targeting in this area are needed.

3. Methods

3.1 Site Selection

Data was collected between May and July 2011 from six coastal fishing villages in the northern region of Antsiranana, Madagascar (Figure 1.). Sites were identified as key shark fishing centres from analysis of the “End of the Line” dataset (C-3 unpublished), and through consultation with local fishermen, fishing associations and knowledgeable individuals. Due to the migratory nature of fishermen, sites were only selected along the east coast during this period to ensure that maximum fishing activity was covered. Further key informant interviews were conducted in the large coastal town of Diego-Suarez.

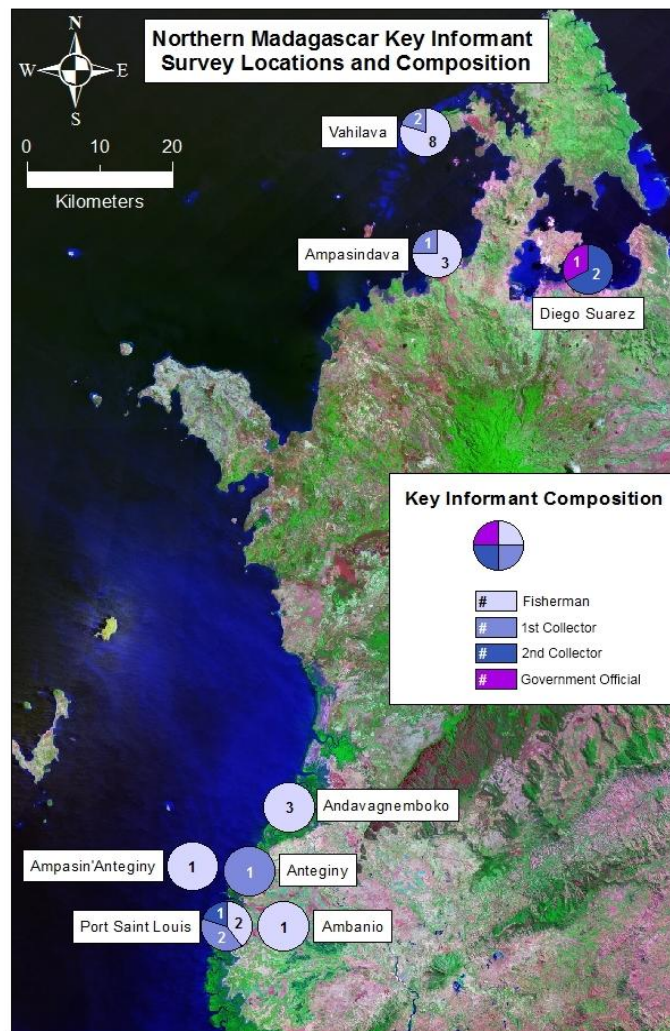


Figure 1. Survey locations for Antsiranana region. The number and type of key informant interviews are shown.

Before conducting interviews at each fishing village, permission was sought from leaders of

the fishing community, and each interview was introduced with a brief statement outlining the purpose of the study. Interviews conducted with commercial traders and a government official were preceded by a telephone conversation to establish whether an interview was possible.

3.2 Analytical Framework

The analytical framework I adopted for this study was a commodity chain analysis to most effectively explore the trade structure surrounding shark fins. This approach has been successfully used to explore the bushmeat trade (e.g. Cowlshaw *et al.* 2005) and trade in agro-forestry products (e.g. Islam, 2008; Bitzer *et al.* 2008), but has been little utilized for other forms of wildlife trade (Brooks *et al.* 2010). For a further discussion of this approach refer to Background 2.3.

This project has focused on how the information gathered can help in the accurate monitoring of the flow of shark fins from fishermen to commercial trader and the identification of points along the commodity chain that show potential for future conservation action. Connections between different actor groups and the means of access into the chain were explored to help provide a thorough understanding of how the trade operates and how conservation action can be tailored to best manage and monitor these activities.

Patterns of price and income for shark fin were analysed for each actor in the commodity chain. To make shark fin prices comparable with previous studies, sizes of fins were categorized according to Cooke (1997). Small were identified as those <15 cm in length, those 15-25 cm long were classified as medium and those 25 cm> were categorized as large.

3.3 Semi Structured Interviews

Three actor groups were identified and available for interview in the shark fin commodity chain: shark fishermen; village collectors (referred to interchangeably as first collectors); and commercial collectors/traders. A government official employed by the Ministry of Fisheries was also interviewed. Data were collected from each actor group using an open ended, semi-structured interview (see Moore *et al.* 2010). The interviews were conducted verbally

in Malagasy using a local translator, experienced in questionnaire assessments of local fishing communities. Interviews were translated directly to allow additional questioning and clarification of any conflicting statements or misunderstandings in respondents' answers and were conducted in an informal, relaxed setting.

The questionnaire format consisted of open-ended questions structured around a central premise followed by probes. The content of the questionnaire varied depending on the actor being interviewed. The questionnaire intended for fishermen (Appendix I.) included questions on species of shark caught, sale of fins, regulations surrounding fishing and trade and general perceptions surrounding sharks. A more detailed description of regulations and commodity chain structure was asked of village collectors and commercial traders (Appendix II.). Each questionnaire was relatively short (<30 min) to minimise survey fatigue.

Selection of key informants for interview was based on a combination of local knowledge and "snowball sampling" (Cowlshaw *et al.* 2005). Fishermen were identified by village members and village chiefs, and were approached on arrival in the village. Village collectors were identified by fishermen and other village collectors. Commercial traders were identified by village collectors, key informants and other commercial traders. Snowball sampling inevitably produces a non-random selection of actors (Cowlshaw *et al.* 2005), however, due to the pyramid structure of the trade, it was felt that this was representative of the structure of the commodity chain as a whole. The number of respondents that were sampled in each actor group were as follows: fishermen (n = 20), village collectors, (n = 6), commercial traders (n = 3), government official (n = 1) for a total of 30 interviews conducted. Two interviews conducted with fishermen were later taken out of the analysis as they had a limited level of activity within the fin trade.

All responses showed a high degree of consistency when analysed and corroborated with direct observation, suggesting respondents were reliable in their information and the data provided was accurate. All trade was conducted openly with no evidence of illegal traffic.

3.4 Landing Site Data

Opportunistic data collection took place at each landing site visited and shark catch details were recorded (Landing Site form: Appendix III). Observations were made of boats that caught shark including the type of boat and the number of crew. Data were collected on lengths of sharks landed; Total length (TL), Fork Length (FL), Standard Length (SL) (Kohler *et al.* 1995), fin measurements; Fin height (FH), Base length (BL), and Anterior Margin length (D1A/P1A) for first dorsal and pectoral fins, Caudal Dorsal Margin (CDM) and Caudal Fork Width (CFW) were recorded for the caudal fin. Sex and indicators of maturity were noted. Photos were taken of the sharks to aid in further identification, following the standard procedure after Compagno *et al.* (2005). Opportunistic measurements of fins already in a state of processing (i.e. cut and drying) were taken in several of the survey locations, however these were not included in any further analysis.

3.5 Species Identification and Use of Local Names

Fishermen and local collectors at two sites (Ampasindava and Port St. Louis) were asked to identify shark species using field identification guides: Compagno *et al.* (2005) and Hennemenn (2001), in order to obtain local names upon species recognition. Direct observation, followed by questioning as sharks were removed from fishing boats, was also used to ascertain local names.

4. Results

4.1 Description of the Fishery

Sharks caught by the traditional fishermen during this study were mostly caught as “non-targeted” catch. Indiscriminate gear (including: line fishing and nets of various mesh sizes) was used to catch a full range of fish species and smaller, juvenile sharks were often caught alongside. As such, there was a large subsistence value to any sharks caught by the traditional fishermen, with smaller sharks often being consumed directly by the fishermen and family rather than being sold for commercial gain. Sharks were landed whole in all cases observed and often processed directly on the beach, the meat being either retained for consumption (as in the majority of cases), or sold along with the fins.

Artisanal fishers differed somewhat from the traditional fishery having greater access to gear specifically targeting large pelagic fish including sharks. Gear included: palangre/longline; *jarifa* nets (large gill nets, baited to target sharks and used in deep water (Cooke, 1997)); and GTZ nets (gill net provided by the German development NGO, GTZ). Artisanal fishers reported a larger volume of sharks caught and sharks comprised a larger proportion of targeted catch. Artisanal vessels reported having longer fishing trips, often with time spent staying on islands in temporary camps. One fisherman stated that to make a profit, he must catch 18 kg of fins per day (of various sizes). Sharks were again landed whole in all cases observed with no reports of finning and discard of the meat at sea. There was one incident of processing occurring on the boat, however, the meat was kept and prepared prior to landing at the beach. The meat was sold with the fins and although fetching a smaller price, it seems that shark meat is still economically important in artisanal fisheries.

4.1.1 Catch composition

From landing site data collected during the sample period, 35 individual sharks were measured ranging from (TL) 27 cm to 131 cm. Of the sharks measured, 18 were male, 16 were female. The majority of shark landings observed ($n = 23$) were from a single fishing vessel, a traditional pirogue. Due to species identification problems, most individuals could not be identified past family level (all Carcharhinidae). However, Scalloped Hammerheads (*Sphyrna lewini*) ($n = 7$) and a Whitetip Reef shark (*Triaenodon obesus*) were confirmed observations. It is likely from the above size range, that all sharks recorded were juveniles,

with the possible exception of *Triagenodon obesus* (length at first maturity 105-109cm, (FishBase)). The largest three sharks observed, all over 100 cm (TL), were caught by artisanal fishermen using vedettes.

Seasonality in the numbers of shark and the sizes of sharks caught was reported by both artisanal and traditional fishers in this study. Collectors and traders reported that they sold shark fin all year round, however, the volume and the size of shark traded changed depending on season. Fishers most often replied that the peak season to catch shark was in the rainy season or “lohataogno”, approximately from November until March. They also reported that this was the best time to catch the biggest sharks.

The use of local names to identify species, names given by fishermen and collectors, were compared with those of Cooke (1997) (Table 4.1.). For some species there was a high degree of variability, this is highlighted below. Fishers and traders did not distinguish between different hammerhead species as is common in many fisheries.

Table 4.1. Chondrichthyan species exploited in Madagascar’s coastal fisheries, with a list of local Malagasy names provided to researchers during the field surveys.

Common Name	Scientific name	This study	Cooke (1997) (Antsiranana Region)
- Spot tail shark - Silvertip shark - Bullshark - Blacktip reef shark*	Carcharhinidae: <i>Carcharhinus sorrah</i> <i>Carcharhinus albimarginatus</i> <i>Carcharhinus leucas</i> <i>Carcharhinus melanopterus</i>	Akio Beloha/Botramavo	- Botramavo
- Scalloped Hammerhead	Sphyrnidae: - <i>Sphyrna lewini</i>	-Antendromaso	-Antendromaso
- Tiger shark	- <i>Galeocerdo cuvier</i>	- Akio Kary	-Akio Kary
- Giant guitarfish	Rhynchobatidae: - <i>Rhynchobatus djiddensis</i>	-Tandrally/Sorokary	
- Sawfish spp.	Pristidae: - <i>Pristis</i> spp.	-Varvana	
- Short tailed nurse shark	Ginglymostomatidae: - <i>Pseudoginglymostoma brevicaudatum</i>	- Ambotso	
- Zebra shark	Stegostomatidae - <i>Stegostoma fasciatum</i>	- Akio Kary+	

*Variable identifications surrounded this species, the two most common local names are given. Included in the table to highlight the overlap of local names.

+Predominantly identified as zebra shark from respondents interviewed in this study, however, variable identifications were also given, comparable to Cooke (1997). Included in the table to highlight the overlap of local names.

4.1.2 Utilization and Processing

Sharks were processed immediately on the beach when landed, with sharks being processed whilst at sea, occurring infrequently. All fins of commercial value were first removed; these included the first dorsal, the pectorals and the lower caudal lobe (Figure 4.1). Head, gills and

intestines were then removed and discarded, jaws (intact) were removed if large enough to sell, individual teeth were also kept for sale.



Figure 4.1 Examples of shark preparation; fins and meat; removal of fins on the beach (A); fins re-drying ready for sale (B); Shark meat processed on the vessel before landing (C); re-drying of shark meat ready for sale (D). (Photos © C. Hopkins).

Shark meat was cut and salted, followed by drying in the sun, often on wooden racks built for this purpose. Meat was then sold locally in the villages or consumed directly by the fishermen depending upon the size of the shark captured. Juvenile sharks were sold whole and wet, bigger sharks are prepared as above and then sold. One trader reported on the export ban for shark meat; in 2007, the Madagascar government stopped the export of shark meat from Madagascar as a quality control. This ban has since been lifted and export of shark meat has resumed with the majority of meat exported to the Comores.

The majority of fins traded are dried by the fishermen. Fishermen were very aware of the different grades of preparation and the resulting effect this had on price. Therefore,

fishermen were keen to prepare the fins well in order to maximise price, some fishermen reported no difference in price due to preparation as it was always of a high quality. All fishermen described the “moon cut” (cutting the fins without meat) as the best way to cut fins ready for sale, followed by putting the fins directly into fresh water mixed with salt for two days. Fins could be kept in salty water for up to a month without any degradation of quality, if there was no opportunity for a quick sale. Fins were then dried in the sun; fishermen gave differing lengths of time for drying, some reported a maximum of two days in order to retain some moisture and therefore make them heavier and more valuable, as fins are sold by weight. Others stated the length of time drying the fins was not important as only the quality mattered to traders. If fins were to be sold immediately, they could be dried directly after cutting.

Traders were reported to put the base of fins back into salty water after sale, and then dry again. Before export, one trader dried the fins on a mattress indoors and then placed them in rice sacks ready to sell. There was no mention of further processing in order to prepare fin fibres (certotrichia).

4.2 Structure of the Commodity Chain

Primary actors in the shark fin commodity chain are summarised in Table 4.2. The trade flow pattern typically followed: fisher > collector > commercial trader > exporter (Figure 4.2). In fishing villages nearer to Diego-Suarez (a main centre of trade), fishermen often bypassed the first collector, considered a middleman by some fishermen. Instead shark fins were taken from the coastal villages into the town and sold directly to the dealers, thus eliminating one actor in the trade and ensuring a higher price for fins. Fishers in other villages sold to village collectors before the fins were sold onto commercial traders in the nearest town. A principle reason for selling to a local collector rather than a commercial trader appeared to be for transport and logistical reasons.

Table 4.2. Primary actors in the shark fin commodity chain. Values are medians and ranges.

Actor	Sample size, n	Age (years)	Time in trade (years)	Alternative income sources
Fisherman	18	40 (19-62)	15 (6-30)	Yes; Fish
1st Collector	6	36 (29-45)	14 (9-21)	Yes; Fish
2nd Collector	3	44*	15 (10-19)	Yes; Other marine resource commodities, including: sea cucumbers, fish

*Only one respondent gave their age

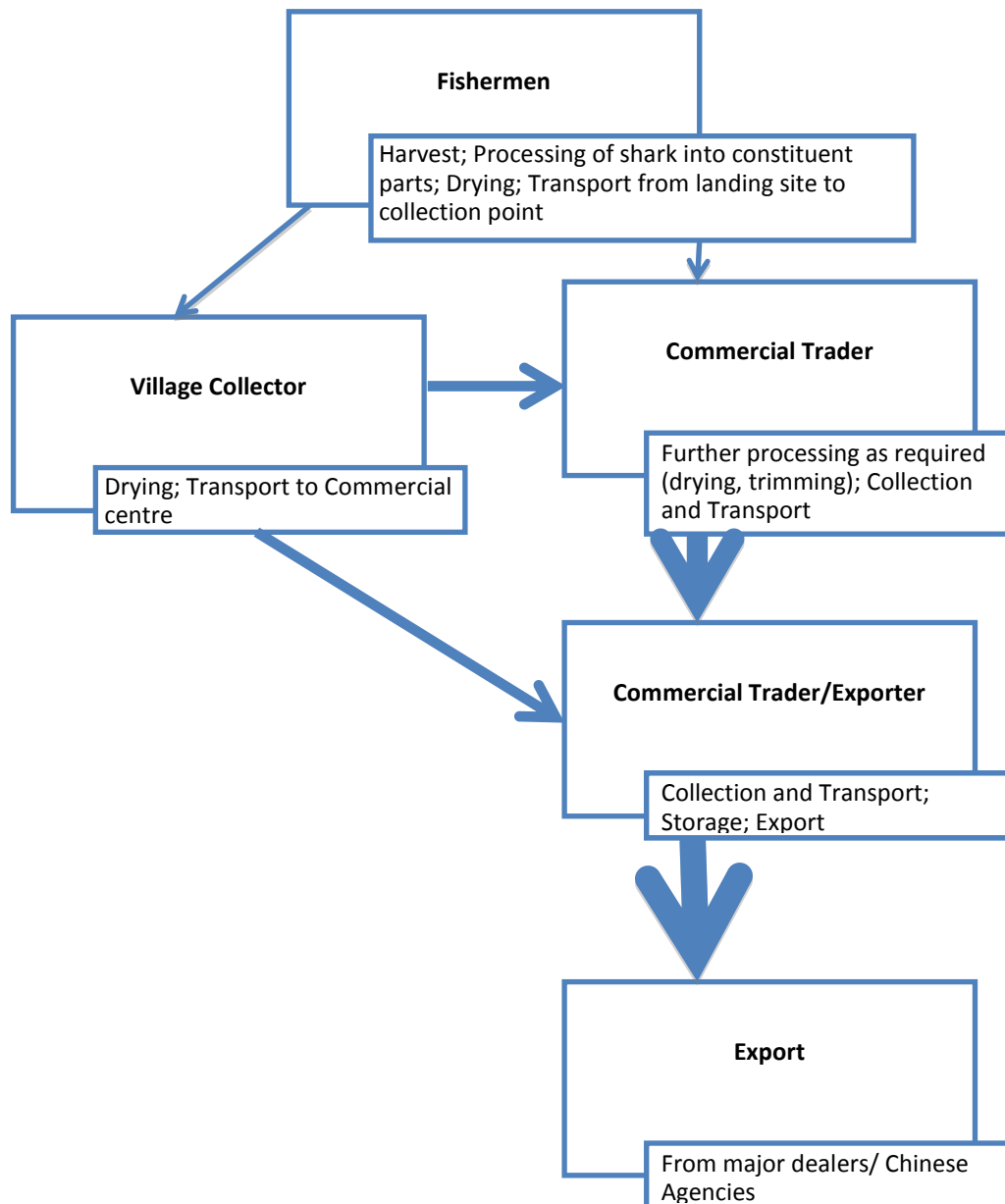


Figure 4.2. Trade Patterns for shark fin as typically described in key informant interviews. Data paucity did not allow a full quantification of the volume of trade. Arrow widths are given as an indication of relative proportions.

4.2.1 Nationality

When asked the nationality of the next person in the chain the majority of fishermen (n= 14) sold to local Malagasy collectors; some fishermen reported selling directly to Chinese collectors (n= 3), and one to an African collector. Fishermen (n=9) replied that the commercial traders were of mainly Chinese nationality (n= 5), with Africans (n=3) and Malagasy (n=2) also operating in the trade. Local collectors (n=4) sold to Chinese traders (n=3) and another to a Malagasy collector (n=1). Commercial traders sold directly to Chinese exporters (n=2).

4.2.2 Trade routes and Transport

A detailed view of the trade routes in Northern Madagascar is provided below (Figure 4.3). Information from key informant interviews provided the following locations as main centres of trade in the Antsiranana region: Mahajanga; Diego; Ambanja; Antsohihy and Nosy Be.

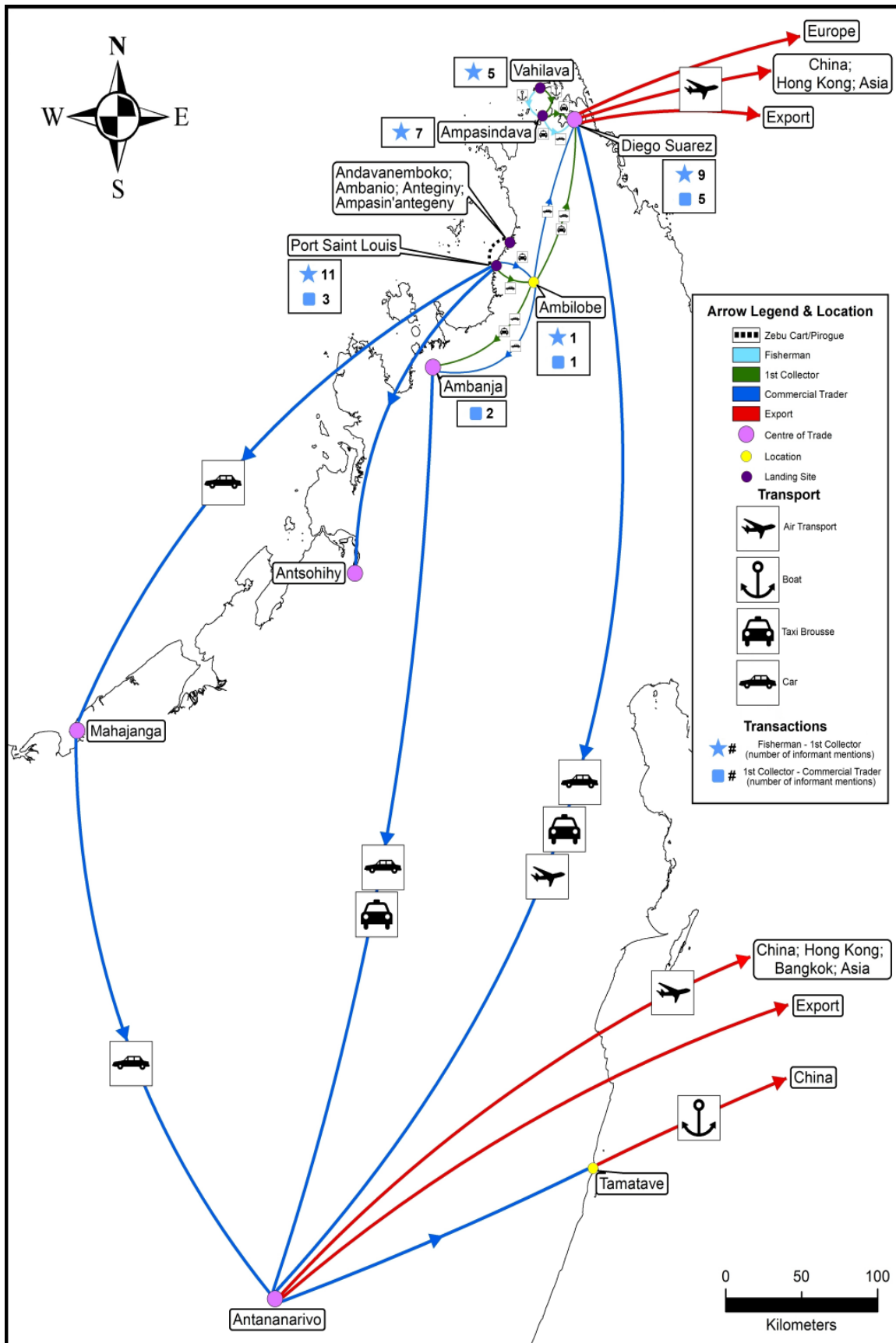


Figure 4.3. Routes of trade in shark fins from artisanal and traditional fisheries for northern Madagascar.

The distances covered by individual collectors varied depending on the volumes of fins they traded. Commercial collectors based in Diego employed staff who toured around the northern villages to collect fins. The road network is very undeveloped, as such the main highways are the primary routes used by all collectors. Smaller collectors would travel to fishing villages personally. Larger collectors often had their own modes of transport, whilst smaller collectors would use public “taxi brousses”. Actors would pay a standard passenger fare on a taxi brousse, however, over an undefined number of kilograms, actors would pay an “excess baggage fee”. Commercial traders generally incurred a higher cost of transportation by travelling longer distances, transporting fins to the centres of trade. Additionally commercial traders sometimes operated beyond the Antsiranana region. Either travelling personally to the south of Madagascar, or employing staff in other regions, usually in different seasons to exploit different sections of the coastline for sharks.

Commercial traders either exported directly from Diego or transported fins to another centre of trade such as Antananarivo (often then transported to Tamatave, a large port, for export by boat). The majority of shark fins were said to be exported to China, Hong Kong and other destinations in Southeast Asia. One fisherman also mentioned Europe as an export location.

4.3 Patterns of Pricing and Income

4.3.1 Pricing

The price of shark meat was reported being considerably lower per kilogram than that of fins, at 1000Ar (0.51) US\$ and low value when compared to zebu (cattle) meat which can fetch 5000 Ar (2.56) US\$ per kilogram.

The value of fins was primarily graded by size (Table 4.3). Fins were classified as small, medium and large with estimations of measurement given in cm (most fishermen used hand measurements as a rough guide). Fins were either “good” or “bad” depending on cut and preparation. However, as previously stated the vast majority of fins in trade were prepared to a high standard in order to achieve a higher price. GTZ were also mentioned in relation to training given to fishermen in order to process shark fin to a trade-able standard.

Table 4.3 Prices paid to fishermen for dry shark fin, mid 1995 and 2011

	1995*	2006	2011	
Fin Size	US \$ per kg	US\$ per kg	Ar per kg**	US \$ per kg ***
small	9		30 000-120 000	15-61
medium	22-45		60 000-180 000	31-92
large	67	52	150 000-300 000	76-153

Source: Cooke (1997) Prices given in US \$ per kg using exchange rate Malagasy Francs (FMG) to US \$ 4450:1

Source: McVean (2006) Prices given in US \$

* Minimum and maximum values taken from key informant interviews with fishermen; prices quoted in Malagasy Francs (FMG) converted into Malagasy Ariary (AR) using standard exchange rate of 5:1

*** Prices converted from Malagasy Ariary (AR) to US \$ using exchange rate 1956:1, the average rate of exchange for the study period.

Fins were considered of the best quality if they possessed a high number of “threads” or cercotrichia. A premium on price was given for “tandraly” or Giant Guitarfish (*Rhynchobatus djiddensis*) fins, with a kilogram of fins reaching 400 000Ar (\$204), as they contained high quality cercotrichia. Two local collectors also stated that this species was decreasing.

For four different size categories of fins, it was possible to compare the sale price per kilogram across three types of actors involved in the trade (Figure 4.4.). This comparison indicated that sales price per kilogram generally increased with each actor along the commodity chain, with the exception of commercial traders and small-medium fins. For large fins, the mark up in price was calculated for each transaction. Fishermen to first collector had an average increase of US\$ 11.55 representing an 11% increase. Compared to first collector to commercial trader, with commercial traders selling large shark fins for US\$ 58.62 more, representing a 49% increase in price.

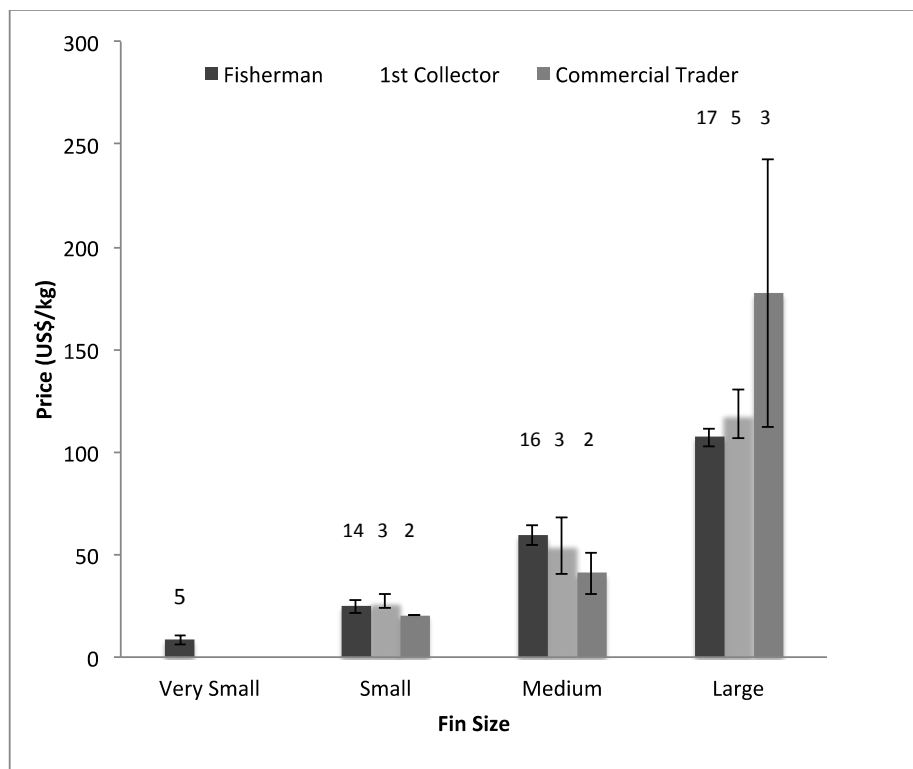


Figure 4.4. Sales price per kilogram along the commodity chain across fin size class and actors. Mean values and standard errors are shown. Sample size is shown above each bar.

Relative profits of traders (with no consideration of transport costs/operational costs for which data were unavailable) were calculated using the average differences in price bought and price sold stated by each individual (Table 4.4).

Table 4.4. Average profits for village collectors and commercial traders along the different sizes of fins (Prices in US\$).

Average Profit	Small	Medium	Large
Village Collectors (2, 2, 4)	10.22	10.22	22.37
Commercial Traders (2, 2, 1)	3.58	5.11	20.45

* Sample sizes (n) shown for each size category

Local collectors and commercial traders (n= 4, n=2) interviewed stated that the prices of shark fins are affected by the exchange rate, predominately that of the Euro (€) and US dollar \$. Other responses from collectors included demand and season.

Following an interview with a government official, it was reported that, for the whole of Madagascar, 10,098 kg of fin were produced in 2010, and 864 kg in the first quarter of 2011. These figures are reported to the Ministry of Fishing and then to the government. However, one commercial trader reported that 400kg of shark fins move through Diego per month alone. It was unclear whether this was including illegal trade or whether the actual volumes of legal shark fins traded are consistently under-reported.

4.3.2 Interlinked commodity chains

Several fishermen mentioned they also harvest sea cucumbers for additional income, this was more apparent in one of the villages to the north (Vahaliva). The commodity chain of sea cucumbers has a similar structure to that of shark fin; often the same collectors were used. Fishermen described how they would catch shark in one season and then catch sea cucumber when there were strong winds preventing long fishing trips. The reason for catching both sharks and sea cucumbers was simply that they are the most valuable resources in the sea.

Commercial traders frequently did not specialise in one type of wildlife trade, like some fishermen, collectors also traded in sea cucumbers as another high value marine resource. One trader showed us a collection of drying shark fins inside his house, and outside sea cucumbers drying in the sun, all for export. One collector of Southeast Asian nationality, specifically trading in sea cucumbers was sighted on several occasions with armed guards presiding over transactions.

4.4 Means of Access and Control

4.4.1 Access to fishing and perceptions of the fishery

Artisanal fishermen often first started fishing shark through the sponsorship of a “patron”; usually fishermen worked on a boat with gear provided by the owner, catching fish or shark, the price of any catch is then set by the patron. The patron, generally a vedette owner, supplied the gear that is known to catch shark. Traditional fishermen in pirogues generally owned their own gear, however, it was usually much less expensive and generally not for catching large pelagic fish. A large proportion of the fishermen interviewed were migrants, moving with season from the east to the west coast. There was no mention of any specific

controls that limit migrant fishers, instead informal arrangements between fishers and the village chiefs seemed normal practice. Technical knowledge required to be a fisherman was stated simply as the methods employed in capture, and locations of sharks.

The majority of respondents (n = 23 respondents; 12 fishermen and 3 local collectors) stated that the number of fishers targeting shark as part of their catch has increased. However, those respondents that replied there were fewer fishers (1 commercial collector and 5 fishermen), stated there were now fewer sharks and that gear used to target sharks was becoming too expensive. One fisherman mentioned that people in some locations are starting to change profession, for example to tourism. Another replied that for the first time he cannot cover the costs of fishing from the income he earns from shark, as he now catches too few.

4.4.2 Access into the trade

The two commercial traders interviewed in Diego responded that they began trading in shark fins through working with Chinese traders, with one stating that he was given a loan by a Chinese agency to begin buying fins. Two of the first collectors also began through the use of a loan to buy fins; one began as a fisherman and after two years had enough money to begin trading himself. The only specific knowledge needed to work in the trade stated by collectors was an appreciation of the values of different fins.

4.4.3 Monitoring and Regulations

Informants were asked both about the monitoring of fishing catch and the monitoring of the trade in shark fins. Fishermen specifically responded to questions about catch stating that Pêche Maritime monitored catch composition and volume. MNP, NGOs and specifically GTZ were also mentioned as monitoring agents.

Monitoring of activities related to sharks was said to be very difficult; pinpointing fishing activity is unfeasible due to the extremely large area to monitor and the lack of resources available. The government official interviewed stated that the government cannot monitor alone and there is a need to work in partnership, for example, with NGOs such as Conservation International, and agencies such as, Madagascar National Parks in order to pool resources.

Permits given to collectors and commercial traders are a way for the Ministry to monitor the trade in shark fins. The government official interviewed in Diego Suarez reported that since 2006, no new fin trader permits have been allocated, instead, only renewal of existing permits is now allowed. At the time of writing as this has not been corroborated. The prices of collector's permits vary according to the marine resource (Table 4.5).

Table 4.5. Prices of permits for marine resource collectors depending upon species collected.

Species*	Amount (FMG)	Amount (Ar)**
Trepang (Sea cucumber)	6 000 000	1 200 000
Shark Fins	5 000 000	1 000 000
Shellfish	5 000 000	1 000 000
Lobster	9 500 000	1 900 000
Shrimp	6 000 000	1 200 000
Elvers	2 000 000	400 000
Crabs	2 000 000	400 000
Squid	6 000 000	1 200 000
Octopus	8 000 000	1 600 000
Bichiques (Gobiidae)	2 000 000	400 000
Fish	800 000	160 000
Bladder, intestines and skin of fish	2 500 000	500 000
Oyster	500 000	100 000
Chevaquines	500 000	100 000
Madagascar Round Herring	500 000	100 000
Algae	6 000 000	1 200 000

Translated from the original French using Google Translate.

** prices quoted in Malagasy Francs (FMG) converted into Malagasy Ariary (AR) using standard exchange rate of 5:1

Of the collectors and commercial traders interviewed (n=9) only one replied there were no laws surrounding trade in shark fins; one first collector also responded that catching juvenile sharks with fins <5cm was illegal. Three respondents were aware of penalties for trading in fins illegally; following law 900023, fins are confiscated and sold to legally trading collectors, with the Madagascar government then keeping any profit. Policemen/gendarmes and Pêche Maritime were the monitoring agents reported to specifically monitor trade.

Pêche Maritime also monitor international fishing vessels for shark catch; resulting in the apparent refusal to provide licenses to fish to Japanese longlining vessels, and two vessels from Thailand, which were found exploiting shark and discarding fish. The reason stated for the changing policy relating to sharks was that they are becoming increasingly endangered in Madagascan waters. One fisherman was also aware of foreign vessels, describing how from 2001, shark catch has increased, but overfishing in this manner has decreased the number of sharks in the area.

5. Discussion

5.1 Problems with identification and quantification

With current knowledge, the monitoring of shark species targeted for the fin trade cannot be conducted with accuracy or reliability through the use of local names (Abercrombie *et al.* 2005; Doukakis *et al.* 2011). Given even the regional variation in local species names (see Cooke, 1997), a full assessment of the species caught along the Madagascar coastline, and those targeted for the fin trade is urgently needed.

The identification problems associated with morphologically similar species, as in multi-shark fisheries, prevent implementing species-specific conservation action and hinder the quantification of catch for targeted species (Abercrombie *et al.* 2005). The giant guitarfish, identified with some reliability in this study, is targeted for the high value of fins, yet reports of dramatic decline are worrying. Schaeffer (2004) reports that this species is targeted for the fin trade by fishermen off the island of Zanzibar, meaning the exploitation of this species could be occurring over a far larger range than that of just Madagascar. Indeed, the development of monitoring methods for this species have been identified as a priority by Clarke (2003). Accurate population estimates of this species are critical.

Another concern highlighted is that catch composition consisted almost exclusively of juvenile sharks. Although this study sampled a small area over a brief time scale, with seasonality possibly being a great contributing factor, the fishing of juvenile sharks has serious implications for the sustainability of these fisheries (McVean *et al.* 2006). The use of more selective fishing gear, targeting much larger individuals has been promoted as a way to achieve fisheries sustainability (McClanahan and Mangi, 2004; McVean *et al.* 2006). However, in a multi-species fishery where sharks are not the only targeted species, this could be an unrealistic management option. A review of the definition of “bycatch” is beyond the scope of this discussion, however, the implications of the blurred boundaries between target and non-target are important for the development of regulations (see R. Short MSc thesis). A more effective approach is possibly the identification and avoidance of areas for key stages in the life history of all species in the area.

The suggestion of a high fishing season for shark between November and January

corresponds to data collected by McVean *et al.* (2006) and Cooke (1997). Reasons why this was the case stated by respondents demonstrated knowledge of ecological processes, which was also reflected in explanations for the apparent declines in shark populations. Anecdotal decreases in the number of several key taxa, including sharks, have been reflected in decreasing trends in production over the past decade (Le Manach, *in press*; Harris, 2007). Cripps (2009) identified southern Madagascar as experiencing a decline in shark fisheries, through decreases in size and numbers of sharks landed, a greater investment in catch per unit effort (CPUE) and increased risk taking through fishing in more remote locations. Reports of decreases in the number of fishermen specifically targeting shark due to the increasing expense of fishing gear are another indication that understanding the socio-economic importance of shark catch to local communities is a priority, as these declines could have significant consequences (Cripps, 2009).

5.2 Structure of the Commodity Chain

5.2.1 Actors in the chain

An important step in implementing conservation action to ensure shark fishery sustainability is understanding how the trade in shark fins functions. By providing a baseline analysis of the structure of the commodity chain, this study facilitates the design of future management plans. Only with collaboration from all participants along the chain, from fisherman to exporter, will the implementation of sustainable practices be successful (Rasolofonirina, 2007).

A key change since Cooke (1997) appears to be the apparent reduction in African actors. Entry of West-African buyers into the trade in the early 1990's disrupted the previous trade flow pattern that included middlemen, with fishermen selling to African actors who then exported directly to Hong Kong. There were only limited mentions of actors of African nationality in this study, highlighting that understanding the incentives behind entry and exit from the commodity chain is an important area for research in order to establish the socio-economic conditions driving trading behaviour. The reason for this apparent exit of African actors could possibly be the constant state of flux in which these systems operate, it is not known yet if this is a long-term change.

All actors interviewed were men, with only two mentions of any women acting in the chain (as commercial traders). This contrasts with the bushmeat commodity chain where the market traders are predominantly women (Mendelson *et al.* 2003). The final market segment in Madagascar is the export market, whereas bushmeat is primarily for domestic consumption.

5.2.2 Income and Pricing

Cooke (1997) reported an increase in price for dried shark fins between 1989 and 1995, from US\$6 per kg to US \$45-47 per kg. The results of this study indicate an increase from US \$67 per kg (Cooke, 1997) to US \$153 per kg for the highest value large-sized fins. This represents a 128% increase in the value of fins. Such high economic returns and the seemingly unflinching demand from Asian markets are suggestive of shark fishing continuing long past the point of sustainability (McVean *et al.* 2006). In multi-species fisheries, or as in the case of bushmeat, rare species are still in danger of dangerous levels of exploitation, whilst generic harvesting still yields economic returns (Brooks *et al.* 2010). Another factor driving the exploitation of sharks to unsustainable levels is possibly perceived rarity and the resulting effect this has on price (see Courchamp *et al.* 2006; Hall *et al.* 2008).

Preliminary analysis of profits along the commodity chain indicates that the actor group receiving the highest profit is local collectors. However, this is most likely due to a function of sample size rather than reflecting true margins along the commodity chain. Across the different size categories, commercial traders make a much larger profit for the larger sizes of fins, possibly indicative of their greater commercial value. Specific price data for shark fins is difficult to obtain and combined with the general lack of openness prevalent in the shark fin industry, taking price estimates from interview data is not always accurate. With a nearly 50% average income dependence on shark for many fishermen (R.Short pers comm.), assessing whether under international pressure to address the fin trade as a predominant driver of shark decline, a fishery viable solely from low value meat sales would be sufficient is a key question for future research.

5.3 Interlinked Commodity Chains

Wildlife studies have tended to focus on one commodity, few have explored the linkages between commodity chains exploiting a similar resource, in which the participation of the same individual actors may occur (Brooks *et al.* 2010). Both shark and sea cucumber fisheries involve high value commodities almost solely for the export market. Both fisheries follow similar patterns of exploitation, being described as “boom and bust” industries with high productivity for a relatively short period, followed by a dramatic decline and either slow recovery or continued very low yield (Camhi *et al.* 1998; Kinch *et al.* 2008). This study has highlighted that in some instances the two commodity chains for these resources appear to be interlinked.

Similarities between the two commodity chains are apparent from fishermen through to collectors. Often fishermen operate in isolated coastal communities where the fishery is critical for subsistence and income (Anderson *et al.* 2010). Fishermen are aware of the economic importance from both of these resources. The operation of the local commodity chains appears very similar; village collectors collect from the gleaners (sea cucumber harvesters) or shark fishermen, then sell to bigger traders, who then transport the resources to the capital for export. Local/village collectors appear to specialise in a particular resource, however, commercial traders appear to have access to multiple species markets, collecting both shark fins and sea cucumbers primarily to satisfy Asian demand.

Another characteristic of both chains is the provision of gear from patrons (of both Malagasy and Chinese nationality) to fishermen, who are then obliged to sell the catch at a lower price. The use of scuba gear to harvest sea cucumbers is illegal by Malagasy law, and following the practice in southern regions, depletion of resources resulted in the migration of many fishers to the north of Madagascar to harvest richer sites (Cripps, 2009; Rasolofonirina, 2007). Production has dropped, and the replacement of traditional fisheries with semi-industrial fisheries using illegal gear is beginning to be mirrored by shark fisheries in the north (pers. comm. R. Short).

Sea cucumber species of high value are still in high demand, fetching up to US\$ 9 a kilo for the most valuable species (McVean *et al.* 2005). However, there has been a shift towards

species of low commercial value (Rasolofonirina, 2007). Indications of declines in sea cucumbers (McVean *et al.* 2005; Rasolofonirina, 2007) are worrying as they are predictive of the situation for shark fisheries. Sea cucumbers have had the attention of much more legislation and control, especially in Madagascar, where specific laws governing harvest attempt to reduce overfishing. It is important to analyse why sea cucumber fisheries have been the focus of targeted management yet the high value commodity shark fishery has not; equally important is addressing the effectiveness of sea cucumber management, what lessons are to be learnt and how they can be applied.

5.4 Points of entry for Conservation action?

5.4.1 Fishermen: the migration issue

Traditionally fishermen have migrated along the west coast to exploit coastal resources, yet the increasing Asian demand has driven some artisanal fishermen, targeting shark and sea cucumbers, to migrate specifically to fish these two commodities (Cripps, 2009). This issue was not addressed in detail during this study (see Raynaud, 2010). However, an east-west migration of artisanal fishers was observed respective of the prevailing winds, with fishermen establishing temporary fishing camps on sites such as Vahilava. In the cases observed the fishermen were equipped with scuba equipment and/or strong nets capable of capturing large pelagic fish, backed by investment from patrons/vedette owners, often from urban centres, hoping to capitalise on fast-money from trade in shark fins (as in Cripps, 2009). The scale and spatio-temporal distribution of these migrations with respect to targeted exploitation of sharks need to be addressed. Coastal migration in Madagascar is increasing as more people seek a living from natural resources, with declining total catches, the ownership of natural resources (in terms of community tenure) and the conflicts possibly arising from this issue need to be investigated (Le Manach, *in press*).

Regulating wildlife commerce at the extraction point by banning the harvest of wild species for direct consumption and trade, has been the primary government management approach for many African countries. The resulting effect is the criminalisation of a large proportion of wildlife trade for which no active management exists (Roe, 2008). Without the commitment and support of communities, effective conservation will not be achieved, thus seeking alternatives to ineffectual blanket bans, involving local resource users should be a necessity.

In the case of the shark fin trade it is evident that for those coastal communities who rely heavily on sharks for income, removing this source of revenue would be a major cause for concern. There are few livelihood alternatives available, however exploration of aquaculture or tourism as options is needed.

5.4.2 Middlemen: the weakest link?

Middlemen have a key role in the commodity chain, in this instance, collectors and commercial traders operated in this fashion, with the inclusion of vedette owners who can employ crew members on boats specifically fishing sharks. Through the provision of gear, sponsored boats and loan agreements, middlemen can control entry into the market and influence the level and distribution of fishing pressure, as far as which species are targeted (Crona *et al.* 2010). Due to their linking position, middlemen are targeted by external actors looking for access to local stocks for exploitation. Driven by a globalised export market, the increases in trade of fisheries resources have precipitated serious ecological and management problems, for example, the depletion of sea cucumbers in the Galapagos (Berkes *et al.* 2006; Toral-Granda, 2008). This “Roving Bandit Syndrome” of serial exploitation and highly mobile actors, combined with the rapid expansion of new markets, greatly accelerates local resource depletion. By occurring so rapidly, local institutions often do not have the capacity to respond fast enough (Crona *et al.* 2010; Berkes *et al.* 2006).

There is evidence of middlemen being targeted by external actors in this study. The propositioning of loan agreements to middlemen in exchange for access to resource extractors was evident through interviews with collectors. Management targeted at these middlemen could potentially affect the reduction in harvesting practices that alter important ecosystem processes, as their tight links to extractors and ability to channel market preferences has great potential for regulating mechanisms (Crona *et al.* 2010). Another important contribution could be the communication of legislation or regulations to fishermen, a lack of awareness in current management practices was observed and if left unaddressed would be a challenge for the introduction of any management strategy.

Wildlife trade driven by Asian market demands evolves quickly (Brooks *et al.* 2010). It is therefore paramount to have flexibility and adaptability in regulatory measures, the absence

of which, has been a major criticism of trade measures in the past (Roe *et al.* 2002). Information regarding socio-economic incentives for each actor in the chain, and the behaviour of consumer markets driving exploitation is a necessity in the formation of such measures (Brooks *et al.* 2010). Monitoring the trade in this manner can communicate changes in shark fisheries to managers (Clarke, 2003).

5.4.3 An international focus for conservation action

From a top-down management approach, CITES regulations provide a framework for asserting some control over the current trade in shark fins. To enforce CITES policy, strong quantitative information is needed, for which Madagascar is severely lacking. Several ways have been proposed of tackling this issue, with the most promising initiatives occurring at a local scale. Observer programmes and community based monitoring programmes, may help begin to quantify the fishery and provide the urgently needed information. Ultimately changes in behaviour at a local level will affect solutions, but the management of elasmobranch species need to be addressed at multiple scales (Berkes *et al.* 2006). Locally, decentralisation of management is likely to be effective with reinforcement of community-tenure, and an ownership of coastal resources by local communities. At a regional level, collaboration between neighbouring shark fishing nations to develop species action plans for those most threatened by trade is a priority. Strong support from the international community is required in order to address these problems in a country with low resources and high biodiversity.

5.5 Remaining Issues for Future Research

5.5.1 Monitoring shark populations

Resolution of the species targeted by the fin trade is urgently needed. Artisanal elasmobranch fisheries are largely deficient in baseline species-specific information, yet the formation of effective management plans and monitoring of exploited populations is dependent upon this data (Bizzarro *et al.* 2009). In order to implement those international regulatory policies which are so critically needed, a thorough assessment of exploitation rates, population estimates and the spatio-temporal distribution of Madagascar's shark populations is paramount.

Trade based methods of monitoring shark populations are becoming increasingly sophisticated (e.g. Clarke, 2005), and provide an empirical approach to the surveillance and estimation of those species exploited and market volume (Barker and Schluessel, 2005). Further quantification of trade volumes at each stage in the commodity chain would provide a solid baseline for elucidating the threat that trade poses to shark populations. Application of these techniques is needed on a regional basis for the whole of Madagascar.

5.5.2 Characterisation of the shark fishery

A full characterisation of the shark fisheries in Madagascar and how this contributes to the shark fin trade will provide the information necessary to understand which management options are most appropriate. Socio-economic studies of the mixed artisanal fishery, and how important the shark catch component is for local livelihoods is necessary in order to understand how various management scenarios will affect local coastal communities (Bonfil, 1997), as is understanding Sociocultural drivers of fishing pressure and monitoring of the economic conditions over time (Cinner, 2009).

5.5.3 Quantification of the trade in shark fins

A combination of methods is required to gain a complete understanding of how the shark fin commodity chain operates at a regional, to national, to international level. Complimentary socioeconomic methods in tandem with quantitative studies aimed at assessing the status of shark populations in trade are fundamental to improving management. Areas still to be addressed include:

- Improving knowledge of the dynamics of trade, understanding the complex array of social interactions, and how local customs and cultures shape the economic exchanges for actors in this trade.
- Current off-take rates, population responses, trade volumes and patterns over time
- Existing institutional frameworks governing resource extraction specific to marine wildlife and trade.
- Interactions with other high value commodities, understanding the interlinking commodity chain of sea cucumbers, and their relationship in terms of socio-economic importance to local coastal communities.
- Response of human populations to changes in the availability of resources, and the

prices over time to predict potential crisis in terms of livelihoods and poverty.

The results of this study have provided the first attempt at a commodity chain analysis for the shark fin trade for northern Madagascar. Using the results of this study as a baseline, it is important that additional research is conducted. Despite the socio-economic importance of the trade in sharks, shark populations do not have well defined management plans based on solid science (Castillo-Géniz *et al.* 1998), and have traditionally received much less attention than other more profitable fisheries (e.g. shrimp). Continual expansion of knowledge in order to develop and implement management for sustainable use is key.

5.5.4 Recommendations for improvements

Limitations specific to this study were mainly the result of logistical, time and staff constraints. Although this study attempted to be representative of fishing communities, most surveys were conducted in villages that were easily accessible due to logistical constraints, and those villages with a prior history of surveys being conducted (e.g. Moore, 2010). This perhaps introduced an element of bias, communities possibly suffered from survey fatigue, therefore, interviewees could have attempted to comply with perceived interviewer attitudes or limited their responses due to unrealised expectations from previous interviews. This study was short and therefore likely affected by seasonality, the availability of informants was perhaps limited due to this study occurring in the shark fishing “off-season”. Attempts were made to ensure interview protocol and survey design followed solid social science research methods, as such, it is felt that the data collected is representative of the current situation within the scope of this investigation. However, the general limitations of the use of questionnaire data for characterising fisheries and species-specific fisheries interactions, (as discussed in Moore, 2010) still apply.

5.6 Concluding Remarks

Data deficient species need robust, pragmatic fisheries assessment frameworks combining biological and socioeconomic information under high uncertainty (Curtis and Vincent, 2008; Dulvy *et al.* 2004). The priority for management of shark fisheries in Madagascar should be to ensure active membership in international agreements, including CITES, CMS and RFMOs; encouraging the collection of data to ensure regional agreements are based on solid non-detrimental findings (Dulvy *et al.* 2008) and continual assessment of how coastal

communities in Madagascar utilise this resource and the implications of trade and fishery at species level. Decisive action is needed at a national, regional and international level to ensure that sharks are exploited sustainably.

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Appendix I.

Key Informant Fishermen Survey

Date:

Location:

Interviewers:

Respondent Details:

Name:	
Age:	
Years of Experience:	
Contact Details:	

Migrant:

1). Shark fishing:

Lead Question:

Can you tell us about the different types of shark you catch?

Probes:

- Which species are most valuable to you and why?
 - Which species are the least valuable to you and why?
 - When you catch shark, how much does an average fishing trip cost?
 - How long is a fishing trip for shark?
 - Has anyone ever given you gear to fish shark with?
 - How and why did you start fishing for shark?
-

2). Sale of sharks:

Lead Question:

Do you land and sell the sharks whole?

Probes:

- Which parts of the shark do you sell?
 - Do people buy the entire shark or just parts of the shark?
 - Are there any specific parts of the shark that have significant value?
 - Do you target certain species of shark for these parts (fins)?
 - Do you need any technical knowledge to be a shark fisherman?
 - Can you tell us what happens to the parts of the shark after you've sold it?
-

3). Shark Finning

Lead Question:

Can you tell us about selling shark fins?

Probes:

- Who do you sell the fins to? Nationality?
- How many people do you sell to?

How much do you sell fins for?
Do you prepare the fins, how?
Does the price change depending on how you prepare the shark fins? If so, how?

4). Fin Processing and Transport:

Lead Question:

Can you tell us what happens to the fins after you've sold them?

Probes:

Where do you land the shark?
Where are the fins going and how are they transported?
By which routes? Do they use roads/fly?
Does this change with season?
In what stage of processing are the fins bought by the different traders?
Do you know the final destination for the fins?

5). Shark fishing regulations:

Lead Question:

Can you tell us about any regulations/laws in relation to shark fins?

Probes:

Does anyone monitor your catch? Why?

Is it possible for you to provide us with any contact details of people who target sharks specifically or trade in sharks?

Appendix II.

Key Informant Fin Trader Survey

Date:

Location:

Interviewers:

Respondent Details:

Name:	
Age:	
Years of Experience:	
Contact Details:	
Nationality:	

1). Overview of the trade:

Lead Question:

Can you tell us about your experience in the shark fin trade?

Probes:

When did you start trading shark fins?

Do you sell sharks at certain times of the year/all year round/when?

Who do you buy the fins from? How many people?

Where in Madagascar (town names/fishing grounds) do the fins you buy come from?

Who do you sell the fins to? How many people? Nationality?

Where in Madagascar (town names/fishing grounds) do the fins you sell go to next?

2). Fin Processing and Transport:

Lead Question:

How are the fins processed and transported?

Probes:

How are the fins transported to you?

By which routes? Do you use roads or fly?

Does this change with season?

In what stage of processing do you buy fins? Do you process the fins anymore before you sell them?

How do you store and transport the fins?

How much does it cost you to transport the fins?

What is the final destination for the fins?

3). Prices of shark fin:

Lead Question:

What can affect the prices of shark fin?

Probes:

How does the price vary with size, species? Do you get a premium on some species?

How much do you buy a kg of fins for/ sell for?

4). Changes in the shark fin market:

Lead Question:

Can you tell us about any changes in the shark fin market over the past 10 years?

Probes:

Have you observed any changes in the species you buy/sell?

Have there been changes in demand/price?

Why did you start trading shark fins?

5). Trade Regulations:

Lead Question:

Can you tell us about any trade regulations/laws in relation to shark fins?

Probes:

What is the purpose of the regulations?

(Who gives out the permits?)

Does anyone break the regulations?

Does anyone monitor the trade?

Are there any taxes on shark fins/ do you have to pay anything to sell them?

Are there any records of amounts sold?

Would it be possible for us to access these records?

Appendix III.

Landing Site Data Collection Sheet

Researchers:

Location:

Date:

Boat No.

No. of Crew:

No.	Species	ID.	TL	SL	FL	Sex	Gravid/Claspers	Notes (Fresh/dried?)

Fin	Fin B L /CFW	Fin Height/CDM	D1A/P1A
Dorsal			
Pectoral			
Caudal			

Est. Value of fins:

Est. Value of meat:

Notes: _____

